Module Description, available in: EN

Analysis of Sequential Data

General Information

Number of ECTS Credits

3

Module code

TSM_AnSeqDa

Valid for academic year

2024-25

Last modification

2023-11-12

Coordinator of the module

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Explanations regarding the language definitions for each location:

- Instruction is given in the language defined below for each location/each time the module is held.
- Documentation is available in the languages defined below. Where documents are in several languages, the percentage distribution is shown (100% = all the documentation).
- The examination is available 100% in the languages shown for each location/each time it is held.

	Lausanne			Lugano	Zurich		
Instruction	**X** E 100%						
Documentation	**X** E 100%						
Examination	**X** E 100%						

Module Category

TSM Technical scientific module

Profile Recommendations

This module is recommended for the following profiles:

	Lausanne
Profile	DS

Lessons

2 lecture periods and 1 tutorial period per week

Entry level competences

Prerequisites, previous knowledge

Basic knowledge in statistics.
Programming with scripting languages.

Brief course description of module objectives and content

Many data sets are temporal by nature.

The first part of the course presents techniques for analysis of time series. It starts from visualization techniques; then it shows techniques for characterizing trend and seasonality; eventually it present structured statistical approaches based on exponential smoothing and arima techniques. Several examples referring to real data sets are shown.

In the second part of the course students learn how to analyze digital signals in different domains, i.e. time and spectral domain; they learn how to extract meaningful features from digital signals suitable for classification. Finally, they learn how to set up and learn statistical models, such as HMMs or DNNs, for recognizing and classifying time series.

The course adopts a practical approach: theoretical concepts are illustrated and applied in specific case studies.

A probabilistic approach is emphasized throughout the course.

The labs are done using environments for scientific programming such as R or Matlab or Python.

Aims, content, methods

Learning objectives and competencies to be acquired

- Students know how to visualize time series and how to characterize their main features.
- Students know how to evaluate forecast accuracy.
- Students know how to model trends, seasonalities and non-stationarities adopting exponential smoothing and ARIMA models.
- Students know how to perform model estimation, model selection and probabilistic prediction with these models.
- Students know different methods to analyse digital signals in different domains
- Students know how to extract important features used in speech processing
- Students learn to apply Bayes rule for classifying digital signals.
- Students can apply modern deep learning approaches to classify digital signals

Module content with weighting of different components

Part 1: Forecasting sequential data

- Time series graphics.
- Main features of time series.
- Assessment of the predictions.
- Exponential smoothing
- ARIMA models

Practical case studies.

Part 2: Analysis and classification of digital signals

- Analysis of digital signals in different domains
- Feature extraction
- Modelling, classification & recognition of digital signals
    - Classic Approaches: Dynamic Time Warping, Vector Quantization
    - Statistical modelling: Hidden Markov Models
    - Deep Learning Approaches

Practical case studies.

Teaching and learning methods

- Ex cathedra
- Self study
- Practical exercises with computer
- Graded homeworks / project.

Literature

Slides will be available covering the topics of the course.

In addition, recommended books are:

For forecasting:

R. Hyndman and G. Athanasopoulos., Forecasting: Principles and Practice, Springer, 2018 (online free textbook at https://otexts.org/fpp2/)

For digital signal processing:

X. Huang, A. Acero, H.-W. Hon: Spoken Language Processing, Prentice Hall, 2001, ISBN 0-13-22616-5

L. R. Rabiner und B.-H. Juang, Fundamentals of Speech Recognition. Prentice Hall, 1993.

D. Yu und L. Deng, Automatic Speech Recognition: A Deep Learning Approach. Springer London, 2014.

Assessment

Certification requirements

Module uses certification requirements

Certification requirements for final examinations (conditions for attestation)

The students will be required to do a small project and some graded homeworks. Such activities will determine 20% of the final grade.

Basic principle for exams

As a rule, all standard final exams are conducted in written form. For resit exams, lecturers will communicate the exam format (written/oral) together with the exam schedule.

Standard final exam for a module and written resit exam

Kind of exam

Written exam

Duration of exam

120 minutes

Permissible aids

Aids permitted as specified below:

Permissible electronic aids

Scientific calculator

Other permissible aids

2 Handwritten summary sheets

Special case: Resit exam as oral exam

Kind of exam

Oral exam

Duration of exam

30 minutes

Permissible aids

No aids permitted